48 Ca 2β⁻ decay 1996Ba80,2000Br63,2000OgZW

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Parent: ${}^{48}\text{Ca}$: E=0.0; J $^{\pi}$ =0+; T_{1/2}=1.9×10¹⁹ y +45-8; Q(2 β -)=4274 4; %2 β - decay=7×10¹ 3

 48 Ca- 48 Ca Adopted Levels. $T_{1/2}(2\beta^-)=2.5\times10^{19}+39-10$ estimated by evaluator from partial $T_{1/2}(2\beta^-)$'s to g.s., 984, 2421, and 2997. Other: $T_{1/2}(2\nu 2\beta^-)=2.87\times10^{19}$ y 51 (2004Ra26; from analysis of Gamow-Teller strengths in 48 Ti(d,2p) and 48 Ca(p,n).) and 3.55×10¹⁹ y 75 (2006Fr03, preliminary; from analysis of Gamow-Teller strengths in 48 Ti(d,2p) and 48 Ca(3 He,t).). 48 Ca-O(2β⁻): From 2003Au03.

 48 Ca- $^{82}\beta^{-}$ decay: 75% +25-38 from 48 Ca Adopted Levels.

1970Ba61 measured $I(2\beta^-)$. 10.6-grams ⁴⁸CaF₂ source in a deep salt mine; streamer chamber. Data were reanalyzed by 1989Ba05.

1986Al05 reanalyzed the 48 Ca β^- decay data of 1985Al17 to obtain a lower limit on $T_{1/2}$ for 48 Ca 0^+ to 48 Ti 2297,2 $^+$ 2 β^- decay transition. The 2014 γ -983 γ coincidence would be the signature for this decay.

1991SaZQ measured $I(2\beta^-)$. Natural CaF₂ crystals containing a total of 0.32 grams of ⁴⁸Ca in Kamioka underground laboratory; 1314 hours.

1991Yo05 measured I($2\beta^-$). Natural CaF₂ crystals containing a total of 43.0 grams of ⁴⁸Ca in coal mine; 7588.5 hours.

1996Ba80,1996Bb01: measured 1e⁻ and 2e⁻; tunnel at Hoover Dam under a minimum of 72 meters of rock; UC Irvine time projection chamber with 2β source as the central electrode in a magnetic field. 42.2 g of CaO₃ (18.5 mg/cm² total thickness with substrate and binder) and 10.3 CaO₃ (5.4 mg/cm²) sources enriched to 73% ⁴⁸Ca. 2440 h exposure for thick source and 4001 h exposure for thin source. 14.0 47 2β events from one analysis of the thin source data resulted in T_{1/2}(2ν[b)=4.3×10¹⁹ y +24-11 with systematic uncertainty of 1.4×10¹⁹ y based on the difference between two different analyses of the thin source and detector efficiency. See 1996Ba80 for more details on the analysis, results from the thick target, and an alternate but consistent with the one adopted by 1996Ba80.

2002Ba33: searched for 48 Ca β^- and $2\beta^-$ decay in a 63.86-GM powder of 48 CaCO₃ (73% 48 Ca). Mondane Underground Laboratory. Measured γ' s with low-background 400 cm³ HPGe; passive shield of 6 cm lead, 10 cm of OFHC copper, and 15 cm of ordinary lead (free space minimized and shield enclosed in Al box flushed by nitrogen to reduce 222 Rn gas).

2000Br63,2000Br44: measured ββ-coincidences; Modane Underground Laboratory, TGV (Telescope Germanium Vertical; 16 HPGe detectors, 20-cm Cu thick shielding, airtight boX), βγ discrimination. 3.5 g 1 of ⁴⁸Ca sources in 8 squares with mixture of 80% CaCO₃ and 20% polyvinyl (77.8% ⁴⁸Ca); 8 similar squares with natural calcium for background estimates. 8700 h run. 5 events associated with $2ν2b^-$ decay of ⁴⁸Ca found in spectrum between 2.65 and 3.45 MeV resulting in $T_{1/2}(2ν2β^-)=4.2×10^{19}$ y +33–13 and an estimated $T_{1/2}(0ν2β^-)>1.5×10^{21}$ y (90% C.L.), $<m>_ν<20.9$ eV. 23 16 events for E>2 MeV resulting in $T_{1/2}(2ν2β^-)=4.0×10^{19}$ y +92–16.

2000OgZW,2000OgZX: measured I(β^-); Oto Cosmo Laboratory, ELEGANT VI (CaF₂ scintillators surrounded by active and passive shields with "delayed- α SYSTEM"). 2589.3 h run. 2 events associated with $0\nu2\beta^-$ decay of ⁴⁸Ca resulting in preliminary $T_{1/2}(0\nu2\beta^-) \ge 2.0 \times 10^{22}$ y.

2005Zd02: pilot study on use of enriched 48 CaWO₄ crystal scintillators to measure 48 Ca $T_{1/2}(0\nu2\beta^-)$. Scintillation properties (energy resolution, α/β ratio, and pulse-shape discrimination ability) and radiopurity of 48 CaWO₄ scintillators studied. Preliminary result using a small non-enriched crystal was $T_{1/2}(0\nu2\beta^-)>6\times10^{19}$ y for a 1374 h measuring time. Estimated sensitivity for ≈ 100 kG 48 CaWO₄ crystals is $T_{1/2}(0\nu2\beta^-)>1.0\times10^{27}$ y.

⁴⁸Ca is a particularly attractive candidate for a $2\beta^-$ decay search. The β^- decay of ⁴⁸Ca to ⁴⁸Sc is suppressed due to the angular momentum conservation law ($J^{\pi}(^{48}\text{Ca}, \text{g.s.})=0^+$ and $J^{\pi}(^{48}\text{Sc}, \text{g.s.})=6^+$) and the $2\beta^-$ decay has the largest available energy release for all 2β candidates (Q($2\beta^-$)=4.274 MeV 4) that is higher than most of the radioactive backgrounds. Therefore, the large space factor compensates for a relatively small nuclear matrix element. See 1993Mo36 for a review of $2\beta^-$ decay searches. Others: see the Nuclear Science References File for theoretical studies, compilations, and reviews. See 1990Al19 for a measurement of $\sigma(\theta)$ from the ⁴⁸Ti(n,p) reaction at E=198 MeV and its possible implications on ⁴⁸Ca $2\beta^-$ decay.

Others: see also 1985A114. See the Nuclear Science References File for theoretical studies, compilations, and reviews. See 1990A119 for a measurement of $\sigma(\theta)$ from the ⁴⁸Ti(n,p) reaction at E=198 MeV and its possible implications on ⁴⁸Ca $2\beta^-$ decay.

⁴⁸Ca 2β⁻ decay 1996Ba80,2000Br63,2000OgZW (continued)

⁴⁸Ti Levels

E(level) [†]	$J^{\pi \dagger}$	$T_{1/2}$ [†]	Comments
0.0	0+	stable	$T_{1/2}(2\nu2\beta^-)$ =4.2×10 ¹⁹ y +22-11 from 2006BaZZ based on a weighted av of 4.3×10 ¹⁹ y +24-11 (1996Ba80. Syst $\Delta T_{1/2}$ =1.4×10 ¹⁹ y) and 4.2×10 ¹⁹ y +33-13 (2000Br63) for decay to this state; syst $\Delta T_{1/2}$ from 1996Ba80 added in quadrature before averaging. Other: >3.6×10 ¹⁹ y (1970Ba61). Theory: 1.3×10 ¹⁹ y≤ $T_{1/2}(2\nu2\beta^-)$ ≤6.0×10 ¹⁹ y (1998Su19). $T_{1/2}(0\nu2\beta^-)$ ≥1.4×10 ²² y for decay to this state (2004Og01; 90% C.L.). Others: >1.5×10 ²¹ y (2000Br63. 90% C.L.), >1.1×10 ²¹ y (1989Ba05), >9.5×10 ²¹ y (1991Yo05. 76% C.L.), and
			>1.6×10 ¹⁹ y (1991SaZQ). Theory: 1.3×10^{25} y≤ $T_{1/2}(0\nu2\beta^{-})$ ≤ 4.0×10^{25} y (1998Su19).
(983.5390 24)	2+		$T_{1/2}(2\beta^-)>4.7\times10^{19}$ y for decay to this state (2002Ba33. 90% C.L.). Other:
			$T_{1/2}(0v2\beta^-) > 1.0 \times 10^{21} \text{ y (1970Ba61)}.$ Theory: $T_{1/2}(2v2\beta^-) = 5.0 \times 10^{26} \text{ y (1984Ha60)}.$
(2421.059 11)	2+		$T_{1/2}(2\beta^-) > 11 \times 10^{19}$ y for decay to this state (2002Ba33. 90% C.L.). Theory: $T_{1/2}(2\nu 2\beta^-) = 3.6 \times 10^{26}$ y (1984Ha60).
(2997.22 16)	0+		$T_{1/2}(2\beta^-) > 9.0 \times 10^{19}$ y for decay to this state (2002Ba33. 90% C.L.). Other: $T_{1/2}(0\nu 2\beta^-) > 8 \times 10^{18}$ y (1986Al05. 95% C.L.).

[†] From the Adopted Levels.

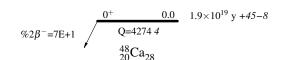
γ (⁴⁸Ti)

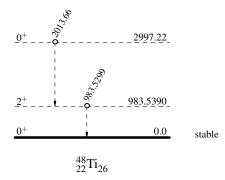
Legend

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Decay Scheme

γ Decay (Uncertain)
 Coincidence
 Coincidence (Uncertain)





[†] From the Adopted Gammas.